No. XIII.

Astronomical observations made at Lancaster, Pennsylvania, chiefly with a view to ascertain the longitude of that borough, and as a test of the accuracy with which the longitude may be found by lunar observation; in a letter from Andrew Ellicott to Robert Patterson.

Read January 21st, 1803.

Lancaster December 16th, 1802.

DEAR SIR,

IF you think the following astronomical observations of sufficient importance, you have my permission to hand them to the Philosophical Society. In making them I had principally two objects in view; *first*, the determination of the longitude of this borough; and *secondly*, the correction of the theory of the satellites of Jupiter, by increasing the number of observations on their eclipses.—The latitude of the place of observation is about 40° 2′ 39″ north.

Nov. 25th, 1801. The observed times, and distances, between the sun and moon's nearest limbs.

	h ′ ″		° ′ ″	
Apparent time.	22 12 1	. . . .	110 29 0	add 15″ for the error of the sextant.
	22 13 16	. . . .	110 28 20	
	22 14 6	. . . .	110 28 0	
	22 15 14	. . . .	110 27 30	
	22 16 6	. . . .	110 27 20	
	22 16 53	. . . .	110 27 0	
Means.	22 14 36	. . . .	110 27 52	

27th, The observed times, and distances between the sun and moon's nearest limbs.

	h ′ ″		° ′ ″	
Apparent time.	23 19 20	. . . .	88 11 10	add 15″ for the error of the sextant.
	23 20 19	. . . .	88 11 0	
	23 21 10	. . . .	88 10 40	
	23 21 45	. . . .	88 10 20	
	23 22 17	. . . .	88 9 50	
	23 23 0	. . . .	88 9 30	
Means.	23 21 18	. . . .	88 10 25	

28th, The observed times, and distances, between the sun and moon's nearest limbs,

	h ′ ″		° ′ ″	
Apparent time.	21 1 24	.....	77 51 20	add 15″ for the error of the sextant.
	21 2 24	.....	77 50 40	
	21 3 13	.....	77 50 20	
	21 3 51	.....	77 49 40	
	21 4 37	.....	77 49 20	
	21 5 39	.....	77 49 0	
Means.	21 3 31	.....	77 50 3	

December 11th, The observed times, and distances, between the sun and moon's nearest limbs.

	h ′ ″		° ′ ″	
Apparent time.	2 42 39	.....	80 29 20	add 15″ for the error of the sextant.
	2 43 24	.....	80 30 0	
	2 44 11	.....	80 30 40	
	2 44 55	.....	80 30 50	
	2 45 34	.....	80 31 0	
	2 46 23	.....	80 31 10	
	2 47 31	.....	80 31 30	
Means.	2 44 57	.....	80 30 39	

12th, The observed times, and distances, between the sun and moon's nearest limbs.

	h ′ ″		° ′ ″	
Apparent time,	1 28 36	.....	92 48 20	add 15″ for the error of the sextant:
	1 29 37	.....	92 48 40	
	1 30 22	.....	92 49 20	
	1 31 19	.....	92 49 40	
	1 32 10	.....	92 50 20	
	1 32 49	.....	92 50 50	
	1 33 42	.....	92 51 30	
	1 34 34	.....	92 52 0	
Means,	1 31 39	.....	92 50 5	

The observed times, and distances, between the moon's western limb, and Aldebaran (α Tauri,) east of her.

	h ′ ″		° ′ ″	
Apparent time,	6 27 3	.....	71 22 30	add 15″ for the error of the sextant.
	6 28 14	.....	71 22 0	
	6 29 14	.....	71 22 0	
	6 29 56	.....	71 21 30	
	6 31 15	.....	71 21 10	
	6 32 16	.....	71 20 50	
	6 33 5	.....	71 20 20	
Means.	6 30 9	.....	71 21 29	

24th, Immersion of the 1st satellite of Jupiter, observed at $12^h\ 34'\ 27''$ mean time, or $12^h\ 34'\ 13''$ apparent time.—The planet and satellites well defined:—magnifying power of the telescope 100.

Jan. 5th, 1802. Immersion of the 2d satellite of Jupiter, observed at $10^h\ 15'\ 6''$ mean time, or $10^h\ 9'\ 10''$ apparent time.—The night fine and clear,—the belts and satellites well defined:—magnifying power 100.

25th, Immersion of the 1st satellite of Jupiter, observed at $9^h\ 5'\ 7''$ mean time, or $8^h\ 52'\ 19''$ apparent time.

Emersion of the 4th satellite of Jupiter, observed at $11^h\ 32'\ 42''$ mean time, or $11^h\ 19'\ 53''$ apparent time. The night was remarkably fine,—the belts and satellites perfectly defined: —magnifying power 100.

February 6th, Immersion of the 2d satellite of Jupiter, observed at $9^h\ 51'\ 46''$ mean time, or $9^h\ 37'\ 15''$ apparent time:—The night a little hazy:—magnifying power 100.

9th, The moon occulted a number of stars in the northern part of that cluster called the Pleiades: the occultations of the three largest were particularly attended to.—The immersons were all instantaneous; but the emersions could not be observed on account of the houses on the west side of the street. Not having either the places, or characters of the stars observed, I have in Fig. 3d, Plate III, laid down the relative positions of the principal ones in the cluster, as nearly as I could do it without the aid of any other instrument than my telescope, and numbered those that were occulted.

	h ′ ″		h ′ ″	
No. 1 immersed at	10 23 54	mean time, or at	10 9 16	apparent time.
2 - - do. - -	10 31 38		10 17 0	
3 - - do. - -	10 53 2		10 38 24	

In the diagram, A B C E represents the dark part of the moon's disk, and A E C D the enlightened part. When the enlightened part was kept out of the field of the telescope, the limb of the dark part was sufficiently visible, and well defined; by which I was enabled, without fatiguing my eye, to trace the approach of the moon to the stars, and pay that close attention so very necessary at the instant of the occultation. The star No. 1 is very small, and seldom visible without the aid of a glass. In each case the star appeared for a few seconds well defined on the edge of the moon's disk.—Various theories have been devised to account for this singular phenomenon, but I am inclined to believe with La Lande, that it is merely an optical illusion*.

* Il arrive souvent dans les éclipses d' étoiles ou de planettes par la lune, que l'astre éclipsé paroît tout entier pendant quelques secondes sur le disque éclairé de la lune; on a attribué ce phénomene á l'atmosphere de la lune, et M. Euler enterprend de prouver son existence par les éclipses de soleil

17th, About $9^h\ 14'\ 9''$ mean time, or $8^h\ 59'\ 47''$ apparent time, the 1st satellite of Jupiter disappeared behind the body of the planet: Jupiter being too near the opposition for the eclipse to be visible.—Observations of this kind cannot be made with great accuracy.

March 10th, Emersion of the 2d satellite of Jupiter, observed at $12^h\ 26'\ 10''$ mean time, or $12^h\ 15'\ 41''$ apparent time:—night remarkably fine, magnifying power of the telescope 100.

16th, Immersion of the 4th satellite of Jupiter, observed at $12^h\ 50'\ 1''$ mean time, or $12^h\ 41'\ 13''$ apparent time:—the night clear, but the moon was so near to the planet that her superior light rendered the satellites less distinct; on which account I suspect that at least $10''$ ought to be added to the time of the immersion, and which I have used in deducing the longitude from this observation: magnifying power 100.

21st, Emersion of the 1st satellite of Jupiter, observed at $8^h\ 2'\ 53''$ mean time, or $7^h\ 55'\ 32''$ apparent time:—the night fine,—magnifying power of the telescope 100.

28th, Emersion of the 2d satellite of Jupiter, observed at $6^h\ 57'\ 57''$ mean time, or $6^h\ 52'\ 45''$ apparent time.

Emersion of the 1st satellite of Jupiter, observed at $9^h\ 57'\ 21''$ mean time, or $9^h\ 52'\ 12''$ apparent time:—night remarkably fine: magnifying power 100.

April 4th, Emersion of the 2d satellite of Jupiter, observed at $9^h\ 34'\ 57''$ mean time, or $9^h\ 31'\ 56''$ apparent time.

Emersion of the 1st satellite of Jupiter observed at $11^h\ 51'\ 36''$ mean time, or $11^h\ 48'\ 36''$ apparent time.—Night uncommonly clear: magnifying power 100.

20th, Emersion of the 1st satellite of Jupiter, observed at $10^h\ 9'\ 28''$ mean time, or $10^h\ 10'\ 40''$ apparent time:—night a little hazy, belts badly defined, magnifying power 100.

May 6th, Emersion of the 1st satellite of Jupiter, observed at $8^h\ 27'\ 56''$ mean time, or $8^h\ 31'\ 33''$ apparent time:—very

(*Mém de Berlin* 1748 *p*, 103.) M, de l'Isle l'attribuoit á la diffraction ou á l'inflection des rayons qui rasent les bords de la lune (Mém, pour servir á l'hist. de l'astron 1738, p. 249.) Ce phénomene, observé par Grimaldi et par Newton (Opt. parte 3d) servoit sur-tout a M. de l'Isle pour expliquer les anneaux que l'on voit autour du soleil dans les éclipses totales; pour moi, je pense que c'est une simple illusion optique occasionée par l'irradiation ou le débordement de lumiere.

Astron. par La Lande Tom. 2d, art, 1991.

hazy, on which account I have deducted 20″ from the observed time of the observation in deducing the longitude from it:—magnifying power 100.

The 2d satellite was expected to emerge about 56 minutes after the 1st: after looking for it at least 4 minutes beyond the calculated time, I discovered that it had emerged in contact with the 1st.

15th. Emersion of the 3d satellite of Jupiter, observed at $9^h\ 45'\ 8''$ mean time, or $9^h\ 49'\ 7''$ apparent time: night clear, —magnifying power of the telescope 100.

29th. Emersion of the 1st satellite of Jupiter, observed at $8^h\ 40'\ 4''$ mean time, or $8^h\ 43'\ 7''$ apparent time:—night clear, magnifying power 100.

June 4th. In the evening, the moon occulted two small stars in (♋) Cancer.

	h ′ ″		h ′ ″	
Immersion of the 1st, at	8 46 0	mean time, or	at 8 48 11	apparent time.
do. of the 2d, at	9 11 12		at 9 13 23	

The last immersion took place so near to the extremity of the moon's southern limb, that it did not appear probable the moon's disk would extend 30″ south of the star.—In each of these occultations, the stars appeared plainly defined on the edge of the moon's disk some seconds before the occultations took place:—in the last case, the star, by being so near to the southern extremity of the moon, appeared to be in contact with her limb for nearly 10 seconds, and for an equal space of time defined on the edge of the disk.

5th. Emersion of the 1st satellite of Jupiter, observed at $10^h\ 34'\ 55''$ mean time, or $10^h\ 36''\ 53''$ apparent time. The night clear, but the belts were scarcely visible, and the limb of the planet uncommonly tremulous: magnifying power 100.

21st. Emersion of the 1st satellite of Jupiter, observed at $8^h\ 52'\ 41''$ mean time, or $8^h\ 51'\ 26''$ apparent time: the planet and satellites well defined, magnifying power 100.

July 14th. Emersion of the 1st satellite of Jupiter, observed at $9^h\ 5'\ 22''$ mean time, or $9^h\ 0'\ 0''$ apparent time. The planet was so low and tremulous that the belts were not discernible:—magnifying power 100. This observation, as well as

those of May 6th, and June 5th, are not to be considered as so accurate as some of the others.

Sep. 11th. Observation on the end of a lunar eclipse.

	h ′ ″		h ′ ″	
☽ began to leave the earth's shadow at	6 54 47	mean time, or	6 58 16	apparent time.
☽ clear of the penumbra at	6 57 15	mean time, or	7 0 44	apparent time.

Longitude by the lunar distances.

		h ′ ″	
Nov. 25th, 1801.	The ☽ from the ☉ long.	5 4 54	West from Greenwich.
27th,	do. do.	5 4 28	
28th,	do. do.	5 4 14	
Dec. 11th,	do. do.	5 5 29	
12th,	do. do.	5 4 7	
	—The ☽ from Aldebaran (α Tauri) do.	5 4 58	
	Mean,	5 4 42	

Longitude west from Greenwich by the eclipses of the satellites of Jupiter, as deduced from the tables of Mr. Delambre, and the British nautical almanac.

			Longitude by Delambre's Tables. h ′ ″	Longitude by the nautical almanac, h ′ ″
Dec. 24th, 1801.	Immersion of the	1st satellite	5 5 2	5 5 39
Jan. 5th, 1802.	do.	2d sat.	5 4 12	5 4 48
25th,	do.	1st sat.	5 5 9	5 5 40
	Emersion.	4th sat.	5 5 45	5 2 11
Feb. 6th,	Immersion	2d sat.	5 4 29	5 5 48
ar, 19th,	Emersion.	2d sat.	5 5 17	5 4 48
16th,	Immersion	4th sat.	5 5 22	5 1 6
21st,	Emersion.	1st sat.	5 5 17	5 6 0
28th,	do.	2d sat.	5 5 12	5 5 15
	do.	1st sat.	5 5 9	5 5 52
April 4th,	Emersion of the	2d sat.	5 5 21	5 5 32
	do.	1st sat.	5 5 17	5 6 2
20th,	do.	1st sat.	5 5 5	5 5 49
May 6th,	do.	1st sat.	5 4 48	5 5 20
15th,	do.	3d sat.	5 5 5	5 11 7
29th,	do.	1st sat.	5 4 59	5 5 18
June 5th,	do.	1st sat.	5 4 47	5 5 9
21st,	do.	1st sat.	5 5 1	5 5 8
July 14th,	do.	1st sat.	5 4 43	5 4 39

Note. The observations made on the eclipses of the 1st satellite on May the 5th, June 5th. and July 14th, are to be considered as doubtful:—see the entries in the preceding journal on those days.

Longitude deduced from the lunar eclipse of Sept. 11th.

	h ′ ″	
If the time when the moon began to leave the earth's shadow be taken for the end of the eclipse, the longitude will be	5 6 44	West from Greenwich.
If the time of the moon's leaving the penumbra be taken for the end of the eclipse, the longitude will be	5 4 16	
Mean,	5 3 50	

By our maps, the borough of Lancaster appears to be about 4′ 29″ in time, west from the city of Philadelphia, which added to 5^h 0′ 37″, the longitude of the latter west from Greenwich, will give 5^h 5′ 6″ for the difference of meridians between the borough of Lancaster and the observatory of Greenwich; which differs but 24″ in time from the mean of the six lunar observations, and only 59″ in time from the widest of them. From this it is manifest, that very great dependance may be placed in the lunar observations, for the determination of the longitude.

In determining the longitude from lunar observations, we have the advantage of increasing the number almost at pleasure, and rendering them so numerous, that the mean of all the results shall be nearly as accurate as the lunar theory itself, which seldom errs so much as 30″ of a degree, and generally much less.

By looking over the longitudes as deduced from the eclipses of Jupiter's satellites, it will be seen that the results from Delambre's tables are much more uniform than those from the nautical almanac, particularly of the 1st, 3d, and 4th satellites; with respect to the 2d, the nautical almanac appears to have the advantage; but it is to be remembered, that the observations made at this place have been too few, and the period too short, to decide on a subject of such nicety: it is nevertheless probable, that when the period is extended, and the number of observations increased on the eclipses of the 2d satellite, that Delambre's tables will be found to be the most accurate.

If a mean of the longitudes deduced from the lunar observations, the eclipses of Jupiter's satellites agreeably to Delambre's tables, and the lunar eclipse be taken collectively, the longitude of Lancaster will appear to be 5^h 5′ 0″.6; and if

a mean of the eight good observations on the eclipses of the 1st satellite of Jupiter be taken, the longitude will be $5^h\ 5'\ 7''.3$ which exceeds the longitude as taken from our maps but $1''.3$ and that of a mean of the whole collectively but $6''.7$. From which it appears, that the longitude may be considered to lie between $5^h\ 5'\ 0.''6$, and $5^h\ 5'\ 7''.3$ west from Greenwich, without the possibility of a material error: I shall therefore for the present call it $5^h\ 5'\ 4''$.

Observation on the going of the Clock.

The pendulum-rod of the clock is made of wood, as being the most convenient for transportation, and not so liable to accidents as the gridiron-rod in removing the clock from one place to another, in which way it has heretofore generally been used.

It was formerly supposed that wood neither expanded, nor contracted, in the direction of the grain, with heat and cold; but this is not strictly true, though the alteration appears much less than from wet and dry. When the atmosphere continues for some time equally saturated with moisture, the clock has always been found to go very regularly, notwithstanding the great and sudden changes we experience in the United States, from hot to cold, and from cold to hot. But the atmosphere being charged at different times, with different degrees of moisture, has a considerable effect, provided those changes from wet to dry, and the contrary, are of sufficient duration: for it requires several days' continuance of a damp, or dry atmosphere, to produce any sensible effect. I have observed for several seasons, that when the weather became warm in the spring, the motion of the clock was accelerated; the contrary would have been the case, had the pendulum-rod consisted of one single bar of metal, because it would have expanded or lengthened, as the weather became warm; but from the motion of the clock being accelerated, it is evident that the pendulum-rod must have contracted, and this was probably occasioned by the dry atmosphere, and drying winds, so prevalent at that season of the year, in this country.

It does not appear from the experience of several years, that the clock would vary more than 12 seconds per diem, with the extreme changes of winter and summer, and wet and dry in our climate; when a single rod of iron would produce a change of 22 seconds per diem, and one of brass 34. Hence a conclusion may be drawn, that wood (though far from being perfect) is preferable to a single rod, either of iron, or of brass.

I am, with great esteem,

your sincere friend,

and humble servant,

ANDREW ELLICOTT.

No. XIV.

Notices of the Natural History of the northerly parts of Louisiana, in a letter from Dr. John Watkins to Dr. Barton.

Read Jan. 1st, 1803.

St. Louis, Ilinois. Octobr. 20th, 1802.
Supposed latitude between 39° and 40°.

DEAR SIR,

In the note which you gave me some time ago, relative to some of the animals, larger trees and shrubs, that are to be found on the west side of the Mississippi; you requested me, that as the questions were made without much regard to order, to trouble myself as little as possible about the arrangement of my answers. I shall therefore proceed, in the spirit of that request, and in the plainest manner, without regard to any particular arrangement, mention such of those animals, trees, and shrubs, as are here to be met with; and state to you as nearly as I can the part of the country where they most abound.

The red fox (canis vulpes) is not known in this part of the country, or any where on this side the Mississippi, immediately